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Spotlight on medicinal chemistry education



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The field of medicinal chemistry is constantly evolving and it is important for medicinal chemists to develop the skills and knowledge required to succeed and contribute to the advancement of the field. *Future Medicinal Chemistry* spoke with Simone Pitman (SP), Yao-Zhong Xu (YX), Peter Taylor (PT) and Nick Turner (NT) from The Open University (OU), which offers an MSc in Medicinal Chemistry. In the interview, they discuss the MSc course content, online teaching, the future of medicinal chemistry education and The OU's work towards promoting widening participation. SP is a Qualifications Manager in the Science Faculty at The OU. She joined The OU in 1993 and since 1998 has been involved in the Postgraduate Medicinal Chemistry provision at The OU. YX is a Senior Lecturer in Bioorganic Chemistry at The OU. He has been with The OU from 2001, teaching undergraduate courses of all years and chairing the master's course on medicinal chemistry. PT is a Professor of Organic Chemistry at The OU and has been involved with the production and presentation of The OU courses in Science and across the university for over 30 years, including medicinal chemistry modules at postgraduate level. NT is a Lecturer in Analytical Science at The OU since 2009 and has been involved in the production of analytical sciences courses, as well as contributing to the presentation of a number of science courses including medicinal chemistry.

Interview conducted by Hannah Coaker and Kasumi Crews, Commissioning Editors.

Q How did you go about designing the syllabus for The Open University's medicinal chemistry postgraduate qualifications [1]?

SP: In developing the curriculum for these qualifications, we worked with experienced colleagues from industry to identify what recently appointed medicinal chemists would require as part of their training. Although the typical person we had in mind was someone who had completed a synthetic organic chemistry PhD in the first 5 years of their post, it became quite apparent that the content was of interest to a much wider

audience. As drug development and discovery in industry is usually undertaken by a multidisciplinary team, it was clear that other scientists within that team (e.g., biologists, biochemists) would also benefit from having a good understanding of the medicinal chemistry involved. In fact we realized that other sectors, such as health professionals, would also be interested. When we designed the curriculum, we therefore ensured that it was accessible to any science graduate and not just for those with synthetic organic chemistry backgrounds or chemistry degrees.

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Q What comprises the core content?

SP: We decided to include the key therapy areas: heart disease, cancer, neuropharmacology, infectious diseases, inflammation and pain. We felt that it was important to give students a good grounding in the core concepts to enable them to access those subjects, and by using well-selected case studies, provide examples of how drugs can be developed to target a particular disease state. It was also really important that we developed students' skills in being able to interrogate information from our online library, e-journals and databases, so that they were taught to access and critically evaluate high-quality, peer-reviewed information. The modules have been designed to teach the core basics of what they really need to know, but also enable students to develop the right transferable skill set, so that whatever topic areas they're working in, or whatever drug team they're working with in the future, they are able to research and identify the information that they require.

Q In what way does the changing nature of R&D impact the organization of the course and its syllabus?

SP: Each year students have to study a core set of materials as well as additional materials they can read to follow a particular area of interest. We regularly update those materials with newly published relevant articles for students to access from our website. In addition to this, our assessment strategy requires students to conduct independent literature searches to find the latest developments in particular areas of the course, so that we can ensure they are gaining insight into what's going on in those fields now.

Q What kind of emphasis do you place on communication skills in the course?

NT: Communication is incorporated in some of their assessments – some of the work the students participate in is group work in which they are expected to be able to communicate their work, for example by preparing a pitch, presentation slides or giving a talk. In addition, students may be required to prepare reports on those activities and reflect back on what they have done, how they have done it and what they could have done better. We also use forums where they have to communicate the science to each other and have discussions, and they also use online 'conferencing' where they can have discussions with their tutors, share presentations and resources with other members of staff or other members of the group if they are doing group work.

SP: We do group work activities in two steps. The first step is guided group work, which involves a tutor

teaching the students the core skills needed to work in a team effectively, and help them to identify the key steps they need to undertake to ensure success. We then ask that group to reflect on what they have learnt and apply those skills in an independent group activity in which they have to organize themselves, undertake the research and develop a proposal for a drug, which they present to an assessor. At each stage the students are encouraged to reflect on what is really at the heart of communication in the team, and how they need to implement that to ensure that that team reaches its objective successfully.

Q The use of online training and teaching materials is becoming increasingly common. Do you think that this method of teaching lends itself well to medicinal chemistry?

PT: I don't think there is any problem at all in teaching medicinal chemistry either face-to-face or through distance teaching – each has their own strengths. There are lots of other challenges in teaching medicinal chemistry generally, but I don't see online teaching as being a real issue. One of the great strengths of online teaching is the ability to be able to develop accessible online materials, such as having an online library where students can go and find articles. I think there are real opportunities with distance teaching: you don't need to go to a particular place to study and you don't have to do it at a particular time. If you're working, then that's a real bonus because from a company's point of view, they don't have to give days off to individuals for training. They can help students study by paying for the course, but the student studies in their own time.

SP: This means that there is no loss of productivity from that member of staff. They carry on working while improving their skills and expanding their knowledge, which helps them in their career. In large pharmaceutical companies, it is also particularly attractive to be able to offer the same training opportunities for staff based in the UK, Europe, Asia or anywhere else in the world.

YX: With the wide use of the internet, accessing knowledge is no longer a big issue. However, how to make good use of knowledge remains an important key skill.

Q How does the online training aspect translate for the practical side of medicinal chemistry?

SP: Our focus is on theory and transferable skills development, therefore we don't do any practical work *per se*. There are some simulations and molecular modeling that students incorporate into their group

work or project work, however those working in industry will be developing bench skills in their workplace. In our discussions with industry, we found that practical work wasn't where the need for improving knowledge and understanding really was. They were more concerned with ensuring chemists understood medicinal chemistry elements of projects, and learnt how to design potential drug molecules and ensure they could be successful molecules further down the production line.

Q In the future, do you think that medicinal chemistry students will be 'programmed' onto career paths earlier in order to maximize their lifetime output?

SP: I'm not convinced they will. I think the nature of the pharmaceutical industry has really changed over the last 5 years and there is much more flexibility in how research operates now. I think the emphasis is shifting onto the individual to take more responsibility for their own training and their own learning. Small biotechs can be quite transient – it's becoming quite common for people to work for 3 or 5 years and then move onto another project in another company. Medicinal chemists therefore need to ensure that their skillset and their knowledge are up to date so they are an attractive proposition to the next company that they want to work for.

NT: A lot of science in the medicinal chemistry and the pharmaceutical sector is becoming more interdisciplinary, so it is becoming more important to have people with an understanding of how chemistry, biology and analytical science all fit together rather than having someone who's a particular type of organic chemist or biologist.

Q What future do you see for partnering between the pharmaceutical industry and universities?

SP: I am sure there will be more of this in terms of the training opportunities. We are already seeing that happening in R&D. Certainly over the last 5 years, there are far more initiatives where industry is collaborating with universities and with other companies, so I'm sure that will seep down through to the degrees and post graduate offerings that are available.

PT: For small and medium industries it is financially very difficult to support their own in-house education, therefore it becomes sensible for them to partner with local education establishments to develop some of those skills in their staff. Studying with The OU, one clear benefit is that staff study in their own time so do

not need days off. Also, our medicinal chemistry masters was designed to be delivered globally to potential students anywhere in the world, and as the industry becomes more global, it becomes necessary to train a global workforce rather than just a local workforce.

Q Do you think there is a danger that courses run in partnership between companies and universities would limit medicinal chemists into working for those particular companies?

SP: I don't think so. Medicinal chemists need to ensure they have a good grounding and good understanding of the core subjects. The skill set they develop and their flexibility provide them with a good grounding for any career that they go into. Industry want staff that are flexible and are able to move from one project to another and from one area of science to another. To have that skill set, you need to be able to interrogate information successfully rather than just narrowly focussing on one particular project that you happen to have the need for now.

YX: The skills developed in our modules are transferable: critical thinking, evaluation of literature, the ability to present results to the scientific community (via posters and presentations) and write review articles for publication are valued across the whole sector.

Q Aside from entering the pharmaceutical sector, where there is a declining number of job opportunities, what other career options are available to medicinal chemistry students? What have your past students gone on to do?

PT: From a chemistry perspective, what's interesting is the number of people that go into chemistry-related work and the number of people who use the wide range of skills developed in a whole range of other career areas. It's the same in medicinal chemistry – there will be a number of people who train in medicinal chemistry and use those skills at the bench as medicinal chemists, but may move onto other areas such as management, marketing and patents, where having medicinal chemistry expertise is important. As well as the medicinal chemistry masters programme, there is a professional science masters at The OU, which involves one of the medicinal chemistry modules and another 60 credit module called 'strategic management in life sciences and healthcare', which is more focused on the business around the pharmaceutical industry. In this module, students learn about the shape of the industry, the strategic choices, finance, scenario planning and other aspects that are important to medicinal chemists as they move on to manage businesses. Some of my students who have

been on the course have gone off to work in clinical trials management and other areas of assurance, so I don't think there is a single career path for medicinal chemists.

YX: Our past students are now working in a wide range of professions including university academics, school teachers, researchers and technicians.

SP: We have quite a broad range of students. Many come from the pharmaceutical industry and small biotechnology companies to broaden their understanding in medicinal chemistry. Others will be science graduates who want to understand the drug-discovery process, or those working in healthcare sectors – we have medics and nurses that take the module. We have had a few students take modules within the masters to support entry into graduate medicine.

Q Do you think the needs of those already working in the field of medicinal chemistry are being met in terms of continuing professional development opportunities?

SP: I think the continuing professional development market is moving away from the traditional model of large pharmaceutical companies having all their training in-house. The way companies are being structured and smaller biotechs taking a product so far and then being bought out has meant that medicinal chemists move around from company to company much more so than they have done previously. Industry is also mindful that they have invested in staff development, only to lose staff to other companies. There has been a shift and medicinal chemists are now taking more personal responsibility for their own career development and becoming more proactive about managing their own training to ensure that they are keeping up to date, rather than leaving it to internal career appraisals from their line managers to tell them they need some training. This will sometimes be in partnership with their employer, and other times if they feel they have missed out on a chance to do training, they will do it themselves.

The growth of Massive Open Online Courses is an interesting development – so far some of them are excellent, but others are not. They are very difficult to quantify as they don't provide students with any sort of badge other than completion, and there is no currency or recognition for them yet.

PT: Massive Open Online Courses are problematic to evaluate because it is difficult to assess how much the student has engaged with the content, and whether they have actually benefited or put the work in to develop themselves.

Q Why do you think people are adopting a more proactive approach to their own training and self development?

SP: I think this is due to the more transient nature of the industry. When people first enter the workforce at 25 after a PhD, they don't tend to stay in the same company until they retire. People tend to move around projects and companies so I think that's the reason why they need to take a much more proactive approach. This is particularly true for the SME part of the sector where companies may only survive 3–5 years if it's moved its products onto the point where it's become a very attractive acquisition for a bigger company, for example. At that point, people may be looking for another job or they may want to move around for personal reasons. Having a CV that demonstrates they're well qualified, keep up to date and are proactive in taking responsibility for their training is very attractive to an employer.

Q One of The OU's missions is to promote equal opportunities for all: what measures are you taking to widen the reach of the course?

SP: These particular Medicinal Chemistry qualifications are available completely online. Previously, there was a requirement for students to come to a day school in Milton Keynes (UK), which wasn't always easy for everyone. By putting it all online, where we have online synchronous and asynchronous sessions where students interact, anybody anywhere can join in. The opportunity to be able to study when you want and where you want makes it more accessible to people who are unable to travel or study at particular times, especially those balancing other commitments or those with disabilities. The OU is the largest provider of higher education for people with disabilities.

PT: We also thought about the fact that students would be studying globally. When I was giving an online tutorial to my project group the other day, there were people joining me from Vancouver, Belgium and Spain. There are some diseases that are very Western and others that are much more global. We tried to give a balance of diseases which aren't just EU- or America-centric, but reflect a more global need of medicinal chemistry. For example, in one of the modules we have a case study on malaria, which is much more prevalent in the developing world.

Q What is The OU doing to improve the representation of women in science?

SP: We have a high proportion of female students studying with us, partly because distance learning enables them to study whilst balancing other fam-

ily responsibilities or their work. The OU has been involved in a broad number of projects for the last 20 years or more that have enabled women to either get back into STEM working or STEM training.

PT: We are also careful in the language we use in terms of the teaching representations and examples of individuals to ensure there is a reasonable distribution of gender and ethnicity.

Q Professor of Education at The OU, Bob Moon, has played a key role in lobbying for improved education in the developing world. What progress has The OU made towards addressing this issue?

SP: The OU has a very wide range of international projects, as part of its social mission to make the greatest use of its educational content. For example, one is the Teacher Education in Sub-Saharan Africa project, which aims to improve the quality and provision of teaching across Africa. Another is Health Education and Training, which focuses on healthcare workers in Africa. The impact of these projects has been enormous – they have trained over half a million teachers and health workers. Some of this work is being expanded into Asia, with projects in Bangladesh, India and Pakistan.

PT: Some of the work in which I have personally been involved is developing an e-learning capacity at the University of Delhi so that they can take in a larger number of students from a range of backgrounds. More recently I have been working on a European funded project which involved developing an e-learning capacity at universities in central Asia (Uzbekistan and Kazakhstan). There are a lot of projects going on and there are a lot of opportunities for development work.

Q What words of advice do you have for an aspiring medicinal chemist?

PT: My advice is quite simple: don't forget your chemistry skills. Chemists, and in particular medicinal chemists, are trained for thinking in various ways to

problem solve, to be reasonably numeric and to think about structures of materials at a molecular level. Those are the key things that I think we can really provide to the pharmaceutical area. I think chemists are naturally creative and chemistry is one of the few creative subjects there are. My PhD students can go into the laboratory and create a compound that's never been made before. It's important to remember that you're bringing those qualities to the team of people that is tackling a particular problem.

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